

THE INVENTION CLAIMED IS

1. A wave-based imaging method, comprising:

directing from within an interspace, one or more predetermined energy waves radially outward along a predetermined axis;

receiving in a predetermined imaging mode, one or more radial scattered energy waves from one or more objects; and

processing said received one or more radial scattered waves, wherein said processing includes application of a wave-based algorithm that can map an angular location and a plurality of frequency parameters of said received scattered energy waves to construct images of said one or more objects.

2. The method of claim 1, wherein said wave-based algorithm comprises a Hilbert space inverse wave (HSIW) algorithm.

3. The method of claim 1, wherein said predetermine imaging mode a plurality of fixed transducers arranged as an annular array, wherein each said transducer is capable of launching a primary field wave and a backscattered field wave is measured on all of remaining said transducers.

4. The method of claim 1, wherein said predetermined imaging mode comprises a single rotating radially outward oriented transducer capable of rotating up to 360 degrees about a predetermined axis.

5. The method of claim 1, wherein said predetermined imaging mode comprises a single transmitter and a receiver aperture further comprising a plurality of receivers, wherein said transmitter and said receiver aperture is capable of rotating up to 360 degrees about a predetermined axis.

6. The method of claim 4, wherein said transducer is arranged about a distal end portion of a catheter for transmitting and receiving predetermined energy wave frequencies.

7. The method of claim 5, wherein at a predetermined angular imaging location, said receiver aperture is configured to receive up to about 90-degrees of angular content resulting from said one or more radial scattered waves.

8. The method of claim 5, wherein said single transmitter and said receiver aperture are arranged about a distal end portion of a flexible substrate for transmitting and receiving ultrasonic energy wave frequencies.

9. The method of claim 1, wherein said images are capable of being formed along a plane perpendicular to a predetermined axis of rotation.

10. The method of claim 1, wherein said energy waves further comprise acoustic frequencies having a range between about 20 MHz and about 60 MHz.

11. The method of claim 1, wherein said energy waves further comprise acoustic frequencies having a range between about 100 Hz and about 10 GHz.

12. The method of claim 1, wherein said energy waves further comprise electromagnetic frequencies having a range between about 1 kHz and about 3 THz.

13. The method of claim 1, wherein said interspace includes automobile parts.

14. The method of claim 1, wherein said interspace includes a living vessel.

15. The method of claim 1, wherein said interspace includes a bore hole.

16. A wave-based imaging method of characterizing a plaque, comprising:  
inserting a catheter having a longitudinal axis and a distal end into an artery, wherein said catheter further comprises a single transmitter disposed about said distal end of said catheter and a receiver aperture further comprising a plurality of receivers additionally disposed about said distal end of said catheter, wherein said transmitter and said receiver aperture are capable of rotating up to 360 degrees about said longitudinal axis of said catheter;  
directing one or more predetermined energy waves radially outward from said single transmitter;  
receiving in a predetermined imaging mode, one or more radial scattered energy waves by said receiver aperture; and  
processing said received one or more radial scattered energy waves, wherein said processing includes application of a wave-based algorithm that can map an angular location and a plurality of frequency parameters of said received scattered energy waves to construct images of said plaque and determine the risk of rupture and/or thrombosis.

17. The method of claim 16, further comprising measuring a fibrous collagen cap thicknesses of up to at least about 800 microns.

18. The method of claim 16, wherein said wave-based algorithm comprises a Hilbert space inverse wave (HSIW) algorithm.

19. The method of claim 16, wherein at a predetermined angular imaging location, said receiver aperture is configured to receive up to about 90-degrees of angular content resulting from said one or more radial scattered waves.

20. The method of claim 16, wherein said images are capable of being formed along a plane perpendicular to said longitudinal axis of rotation.

21. The method of claim 16, wherein said energy waves further comprise acoustic frequencies having a range between about 20 MHz and about 60 MHz.

22. A wave-based imaging method of characterizing a plaque, comprising:  
inserting a catheter into an artery,  
directing one or more predetermined energy waves radially outward  
and receiving one or more radial scattered energy waves from a distal end of said catheter;

collecting a radial scattered tomographic data baseline of said artery's tissue;

measuring an applied external pressure to said artery;

obtaining a deformation radial scattered tomographic data set of said artery's tissue after application of said external pressure; and

processing said radial scattered tomographic data baseline and said deformation radial reflected tomographic data set to produce a final image indicating elasticity of said artery to characterize said plaque, wherein said processing includes application of a wave-based algorithm that can map an angular location and a plurality of frequency parameters of said received scattered energy waves.

23. The method of claim 22, wherein said wave-based algorithm comprises a Hilbert space inverse wave (HSIW) algorithm.

24. The method of claim 22, wherein said catheter further comprises a single rotating radially outward oriented transducer capable of rotating up to 360 degrees about a predetermined axis.

25. The method of claim 22, wherein said catheter further comprises a single transmitter and a receiver aperture further comprising a plurality of receivers,

wherein said transmitter and said receiver aperture is capable of rotating up to 360 degrees about a predetermined axis.

26. The method of claim 25, wherein said transmitter and said plurality of receivers further comprise transducers.

27. The method of claim 22, wherein said final image is capable of being formed along a plane perpendicular to a predetermined axis of rotation.

28. The method of claim 22, wherein said energy waves further comprise acoustic frequencies having a range between about 100 Hz and about 10 MHz.

29. The method of claim 22, wherein said energy waves further comprise electromagnetic frequencies having a range between about 1 kHz and about 3 THz.

30. A wave-based imaging apparatus, comprising:  
a flexible substrate having a longitudinal axis and a distal region;  
one or more elements disposed on said distal region; wherein  
each of said one or more elements is capable of directing one or more

predetermined energy waves radially outward and wherein each of said one or more elements is capable of receiving one or more radial scattered energy waves from one or more objects; and

wherein images of said one or more objects may be constructed from data obtained with said one or more elements, which includes application of a wave-based algorithm that can map an angular location and a plurality of frequency parameters of said received scattered energy waves.

31. The apparatus of claim 30, wherein said wave-based algorithm comprises a Hilbert space inverse wave (HSIW) algorithm.

32. The apparatus of claim 30, wherein said one or more elements comprise a plurality of fixed transducers arranged as an annular array, wherein each said transducer is capable of launching a primary field wave and a backscattered field wave is measured on all of remaining said transducers.

33. The apparatus of claim 30, wherein said one or more elements comprise a single rotating radially outward oriented transducer capable of rotating up to 360 degrees about said longitudinal axis.

34. The apparatus of claim 30, wherein said one or more elements comprise a single transmitting transducer and a receiver aperture further comprising a plurality of receiving transducers, wherein said transmitter and said receiver aperture are capable of rotating up to 360 degrees about said longitudinal axis.

35. The apparatus of claim 34, wherein at a predetermined angular imaging location, said receiver aperture is configured to receive up to about 90-degrees of angular content resulting from said one or more radial scattered waves.

36. The apparatus of claim 30, wherein said images are capable of being formed along a plane perpendicular to said longitudinal axis of rotation.

37. The apparatus of claim 30, wherein said energy waves further comprise acoustic frequencies having a range between about 100 Hz and about 300 Hz.

38. The apparatus of claim 30, wherein said energy waves further comprise acoustic frequencies having a range between about 20 MHz and about 60 MHz.

39. The apparatus of claim 30, wherein said energy waves further comprise electromagnetic frequencies having a range between about 100 KHz and about 3 THz.

40. The apparatus of claim 30, wherein said apparatus can be arranged to image interspaces within automobile parts.

41. The apparatus of claim 30, wherein said apparatus can facilitate plaque characterization to determine the risk of rupture and/or thrombosis within a living vessel.

42. The method of claim 30, wherein said apparatus can be arranged to image one or more objects from within a ground crevice.

43. The apparatus of claim 30, wherein said apparatus can be arranged to image one or more objects from within a borehole.

44. The apparatus of claim 30, wherein said apparatus can be arranged to image a medium within a waste contaminant container.

45. A wave-based imaging apparatus to characterize plaque, comprising:

- a catheter having a longitudinal axis and a distal region;
- a single transmitting transducer adapted to transmit energy waves and a receiver aperture further comprising a plurality of receiving transducers adapted to receive radial scattered energy waves, wherein said transmitter and said receiver aperture are disposed on said distal region and capable of rotating up to 360 degrees about said longitudinal axis; and
- wherein intravascular tomography images of one or more objects may be constructed from data obtained from said plurality of receiving transducers, which includes application of a Hilbert space inverse wave (HSIW) algorithm that can map an angular location and a plurality of frequency parameters of said received scattered energy waves.

46. The apparatus of claim 45, wherein a diameter of said distal region that comprises said transmitting transducer and said receiving aperture is between about 0.25 millimeters and about 5.00 millimeters, thereby enabling intravascular use.

47. The apparatus of claim 45, wherein said apparatus can facilitate the risk of rupture and/or thrombosis within a living vessel.

48. The apparatus of claim 45, wherein said energy waves further comprise acoustic frequencies having a range between about 20 MHz and about 60 MHz.

49. The apparatus of claim 45, wherein said energy waves further comprise acoustic frequencies having a range between about 100 Hz and about 10 GHz.

50. The apparatus of claim 45, wherein said energy waves further comprise electromagnetic frequencies having a range between about 1 kHz and about 3 THz.